

# CLAIMS

1. A radio communication apparatus having ad-hoc communication means for building an ad-hoc network with other nearby radio communication apparatus and performing communication with the other radio communication apparatus by radio,

wherein a radio communication apparatus that manages the entire ad-hoc network is a master and a radio communication apparatus that performs radio communication within the ad-hoc network under the management of the master is a slave, and

wherein the ad-hoc communication means comprises:

node type setting means for searching the ad-hoc network for the master and setting the node type of the radio communication apparatus to any of the master and slave on the basis of the search result;

set-up information acquisition means for, when the node type of the radio communication apparatus is set to the slave, transmitting and receiving control signals to and from the master to acquire set-up information required for communication with any of the master and slave in the ad-hoc network and storing the set-up information in storage means; and

data signal transmission means for directly transmitting and receiving data signals to and from any of the master and slave in the ad-hoc network in accordance with the set-up information acquired from the master.

2. The radio communication apparatus according to claim 1, wherein the ad-hoc communication means comprises:

node information collecting means for, when the node type of the radio communication apparatus is set to the master, transmitting and receiving control signals to and from each slave in the ad-hoc network to collect node information of each slave;

network information updating means for updating network information concerning the ad-hoc network on the basis of the collected node information of each slave and storing the updated network information in the storage means; and

network information delivery means for delivering the network information to each slave in the ad-hoc network.

3. The radio communication apparatus according to claim 2, wherein the ad-hoc communication means comprises set-up information transmitting means for, in response to a communication request from a slave in the ad-hoc network, allocating network resources on the basis of the network information stored in the storage means and transmitting set-up information in which the allocation of the network resources is specified to the slave that has issued the communication request, and

wherein the network information updating means updates the network information on the basis of the set-up information and stores the updated network information in the storage means; and

the network information delivery means delivers the updated network information to each slave in the ad-hoc network.

4. The radio communication apparatus according to claim 1, comprising mobile communication means for performing communication with a base station of a mobile communications network by using TDD-CDMA system,

wherein the ad-hoc communication means uses, in communication within the ad-hoc network, the same TDD-CDMA system that is used in the mobile communications network.

5. An ad-hoc system including a master and slaves, the master being a radio communication apparatus that manages an entire network and the slaves being radio communication apparatuses which perform radio communication under the management of the master,

wherein the master comprises:

node information collecting means for collecting node information of each slave by transmitting and receiving control signals to and from each slave in the ad-hoc network;

network information updating means for updating network information concerning the ad-hoc network on the basis of the collected node information of each slave and storing the updated network information in storage means;

set-up information transmitting means for, in response to a communication request from a slave in the ad-hoc network, allocating network resources on the basis of the network

information stored in the storage means and transmitting set-up information in which the allocation of the network resources is specified to the slave that has issued the communication request; and

network information delivery means for delivering the network information to each slave in the ad-hoc network, and

wherein the slave comprises:

storage means for storing network information acquired from the master;

set-up information acquisition means for, when the slave intends to initiate communication with any of the master and other slave in the ad-hoc network, transmitting a communication request to the master to acquire the set-up information; and

data signal transmission means for transmitting and receiving data signals to and from any of the master and other slave in the ad-hoc network in accordance with the set-up information and the network information acquired from the master.

6. The ad-hoc system according to claim 5, wherein a radio network in a star topology at the center of which is the master is formed for transmitting the control signals; and

a radio network is formed in a mesh topology for transmitting the data signals.

7. A communication system in which TDD-CDMA system is used for communication between a base station of a mobile

communications network and a radio communication apparatus that acts as a mobile station;

wherein the radio communication apparatus has ad-hoc communication means for building an ad-hoc network with other nearby radio communication apparatus and performing communication with the other radio communication apparatus by radio, and uses the same TDD-CDMA system and the same frequency band that are used in the mobile communications network, and

wherein the radio communication apparatus includes, as radio interfaces, a first interface for performing communication with the base station, a second interface for performing communication with other radio communication apparatus in the ad-hoc network, and a third interface for relaying communication between other radio communication apparatus in the ad-hoc network and the base station;

the radio communication apparatus is configured to be capable of connecting to an authentication server of an IP network as a client; and

the authentication server has an interface for performing communication with a home location register of the mobile communications network.

8. A communication system comprising:

a base station of a mobile communications network;

a radio communication apparatus which performs communication with the base station by using TDD-CDMA system;

a management equipment which, when the radio communication apparatus attempts to access the mobile communications network, receives user information of the radio communication apparatus via the base station and validates a user of the radio communication apparatus on the basis of the user information; and

an authentication server which is incorporated in an IP network;

wherein the radio communication apparatus comprises ad-hoc communication means for building an ad-hoc network with other nearby radio communication apparatus and performing communication with the other radio communication apparatus by radio, the ad-hoc communication means using, in communication with the other radio communication apparatus in the ad-hoc network, the same TDD-CDMA system and the same frequency band that are used in the mobile communications network and having the function of relaying communication between the other radio communication apparatus in the ad-hoc network and the base station;

the radio communication apparatus is configured to be capable of connecting to the authentication server as a client and, when connecting to the IP network through the authentication server, transmits the user information to the authentication server; and

the authentication server has an interface for connecting to the management equipment and, upon receiving the user information from the radio communication apparatus, validates the user in cooperation with the management equipment, and

when the user is successfully authenticated as a result of the validation, permits the radio communication apparatus to connect to the IP network.

9. A radio communication apparatus which builds an ad-hoc network with other nearby radio communication apparatus, performs communication with the other radio apparatus by using any of TDD-CDMA, TDD-TDMA, and TDD-OFDM communication systems, and performs communication with a base station of a mobile communications network by using the same communication system and the same frequency band that are used in the communication with the other radio communication apparatus in the ad-hoc network,

the radio communication apparatus comprising:

relay means for relaying communication between the other radio communication apparatus in the ad-hoc network and the base station; and

radio interfaces including a first interface for performing communication with the base station, a second interface for performing communication with the other radio communication apparatus in the ad-hoc network, and a third interface for relaying communication between the other radio communication apparatus in the ad-hoc network and the base station.

10. The radio communication apparatus according to claim 9, comprising ad-hoc communication means for performing

communication with other radio communication apparatus in the ad-hoc network using the second interface,

wherein the ad-hoc communication means comprises node type setting means for searching the ad-hoc network for a master and setting the node type of the radio communication apparatus to any of the master and slave on the basis of the search result;

when the node type setting means sets the node type to master, the ad-hoc communication means acquires node information from each slave in the ad-hoc network, updates network information concerning the entire ad-hoc network on the basis of the node information, stores the updated network information in storage means and, in response to a capacity request from any of the slaves in the ad-hoc network, allocates a communication channel on the basis of the network information stored in the storage means and transmits an allocation message to the slave that has issued the capacity request; and

when the node type setting means sets the node type to slave, the ad-hoc communication means transmits the node information to the master and, when performing communication with any of the master and slaves in the ad-hoc network, specifies any of the master and the slaves as a communication target in the capacity request, transmits the capacity request to the master, obtains the allocation message from the master, and then directly communicates with any of the master and slaves specified as the communication target in accordance with the allocation message.



11. The radio communication apparatus according to claim 9, wherein, in a communication protocol of the second interface, layer 3 of OSI (Open Systems Interconnection) reference model is composed of an RRC (Radio Resource Control) sub-layer, and layer 2 is composed of an RLC (Radio Link Control) sub-layer and an MAC (Medium Access Control) sub-layer;

an SH-CCH (Shared Control Channel) and a DTCH (Dedicated Traffic Channel) are used as logical channels connecting the RLC sub-layer and the MAC sub-layer, an FACH (Forward Access Channel), an RACH (Random Access Channel) and a DCH (Dedicated Channel) are used as transport channels connecting the MAC sub-layer and layer 1, and an S-CCPCH (Secondary Common Control Physical Channel), a PRACH (Physical Random Access Channel) and a DPCH (Dedicated Physical Channel) are used as physical channels for communication between Layer 1 and nodes; and

the SH-CCH, the RACH and the PRACH are mapped to channels for control signals from a slave to a master, the SH-CCH, the FACH and the S-CCPCH are mapped to channels for control signals from a master to a slave, and the DTCH, the DCH and the DPCH are mapped to channels for data signals.

12. The radio communication apparatus according to claim 9, wherein the relay means allocates a communication channel in cooperation with the base station, applies protocol conversion to signals received from one of the other radio communication apparatus in the ad-hoc network and the base station, and transmits the signals to the other through the communication channel.

13. A communication system comprising:

a base station of a mobile communications network;

a mobile station which performs communication with the base station by using TDD-CDMA system;

a management equipment which, when the mobile station attempts to access the mobile communications network, receives user information of the mobile station via the base station and validates a user of the mobile station on the basis of the user information; and

an authentication server of an IP network based on the TCP/IP,

wherein the mobile station is configured to be capable of connecting to the authentication server as a client and, when connecting to the IP network through the authentication server, transmits the user information to the authentication server; and

the authentication server has an interface for connecting to the management equipment and, upon receiving the user information from the mobile station, validates the user in cooperation with the management equipment and, when the user is successfully authenticated as a result of the validation, permits the mobile station to connect to the IP network.

14. The communication system according to claim 13, wherein the management equipment is a home location register having a subscriber information database.

15. The communication system according to claim 13, wherein the user information is stored in an SIM card attached to the mobile station.

16. The communication system according to claim 13, wherein the mobile station is a radio communication apparatus which builds an ad-hoc network with other nearby radio communication apparatus to perform communication with the other radio communication apparatus by radio, and the mobile station uses, in communication within the ad-hoc network, the same TDD-CDMA system and the same frequency band that are used in the mobile communications network.

17. The communication system according to claim 16,  
wherein the mobile station comprises relay means for relaying communication between the other radio communication apparatus in the ad-hoc network and the base station;

the mobile station is equipped with first, second, and third interfaces as radio interfaces, performs communication with the base station through the first interface, and performs communication with the other radio communication apparatus in the ad-hoc network through the second interface; and

when relaying communication between the other radio communication apparatus in the ad-hoc network and the base station, the mobile station performs communication with the base station through the third interface.

18. The radio communication apparatus according to claim 1, wherein the ad-hoc communication means uses, in communication within the ad-hoc network, the same frequency band and the same communication system that are used in communication with the base station of the mobile communications network, the communication system being any of the TDD-CDMA, TDD-TDMA, and TDD-OFDM communication systems.

19. The radio communication apparatus according to claim 1, wherein the node type setting means performs, when setting the node type, processing for detecting a pilot signal transmitted from the master and, when the node type setting means detects the pilot signal, the node type setting means sets the node type of the radio communication apparatus to slave; when the node type setting means does not detect the pilot signal, the node type setting means sets the node type of the radio communication apparatus to master; and then the node type setting means performs processing for repeatedly broadcasting a pilot signal at predetermined intervals.